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NEW OR LITTLE-KNOWN VERTEBRATES FROM THE PERMIAN OF TEXAS.

IN 1880 Cope gave the first description and figure of the scapula of *Eryops*.[1] He had at the time only the lower portion of the scapula with the co-ossified coracoid, bearing the cotylus for the humerus. Later, in 1888,[2] he published a figure of the shoulder-girdle with the clavicles and interclavicle in place. As in the first specimen, the distal end of the scapula was missing, but there was a small fragment of a distinct bone joining the upper edge of the scapula, which he regarded as possibly a portion of the scapula, but was uncertain as to its exact position. In 1899, Broili[3] described a skeleton of *Eryops* in which he identified the fragment mentioned in Cope's description as the epiclavicle or cleithrum. In 1898[4] the author mentioned the presence of a cleithrum on the distal end of a scapula which was regarded at the time as reptilian. The element is indicated by a small fragment of the bone, which is attached by strong rugose grooves and ridges to the scapula. The specimen (No. 76) of the collection of the University of Chicago, probably belongs in the genus *Eryops*, but to a species distinct from *megacephalus*. It is shown in Fig. 1. It is the third scapula described below.

In looking over the collection of the Chicago University I find a nearly perfect scapula of *Eryops* (No. 182), with a complete cleithrum in position. The bones have been badly broken, but are little distorted and differ so much from the type species that I refer them to a new species under the name *Eryops latus*. The general outline of the bones is shown in Fig. 2. The scapula differs from that of *Eryops megacephalus* in the relatively greater breadth of the coracoidal region and the straightness of the antero-internal edge. The cleithrum is a queerly shaped bone;

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[1] *Proc. Am. Phil. Soc.*, Vol. XIX, p. 51, 1880.

[2] *Trans. Am. Phil. Soc.*, Vol. XVI, p. 362, 1888.

[3] *Paleontographica*, Vol. XLVI, p. 61, 1899.

[4] *Am. Nat.*, Vol. XXXII, p. 70, 1898.

the posterior end is thin and greatly expanded so that it overlaps the upper portion of the distal end of the scapula and is closely applied to it as a thin scale; it is convex outwardly. The anterior two-thirds of the bone is rounded and rod-like. It lies close to the upper edge of the scapula, but is to be described as applied to it rather than being articulated with it, for where the bone is broken away the edge of the scapula is smooth and complete. The edges of the rod-like portion of the cleithrum were evidently extended as narrow and very thin wings. The anterior edge is sharp and marked with rugosities where it joined the clavicle, as indicated in Cope's figure. Broken fragments of the clavicle were found with the scapula and show that the anterior face of the proximal portion was marked with very deep and rugose striations and ridges. The evidence of the cleithrum afforded by this specimen makes our knowledge of the shoulder-girdle of *Eryops* complete.

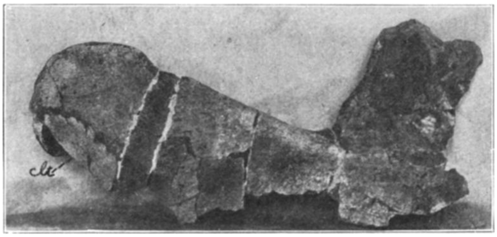


FIG. 1.—Scapula of *Eryops sf.*, showing attachment of cleithrum. *clt.* Left side.

MEASUREMENTS OF E. LATUS.

Breadth across epicoracoid region	.182$^{\mathrm{m}}$
Breadth opposite center of face for humerus	.079
Width of scapula at middle	.073
Greatest length scapula	.371
Greatest length of cleithrum	.237

In the process of investigating this scapula it becomes very evident that a close similarity existed, superficially, between the scapula of *Eryops* and that of the Pelycosaurian reptiles, and this led to a search for points that might be used in their separation. Baur says that there is no ossified coracoid in the Stegocephali and that the cleithrum does not occur in the reptiles, *Pareiasaurus* excepted. Williston mentions the presence of scapula, coracoid and pre[epi]coracoid in *Eryops*, but says that they are so closely united that the sutures are indistinguishable.

Broili describes a scapula and coracoid in the same genus, but evidently regards as coracoid the bone usually described as epicoracoid, leaving the part here described as coracoid absent or cartilaginous. Cope speaks of the coracoid as distinctly recognizable, but figures no suture and describes the epicoracoid as probably present but not recognizable. There thus seems to be considerable difference of opinion regarding the presence of the coracoid. From considerations cited below it seems to me that the coracoid was cartilaginous, but if so the anterior end of the scapula assumed a strikingly similar form to the coracoid of the reptiles, sheltering the whole of the humeral cotylus, which in the reptiles is shared between the coracoid and scapula.

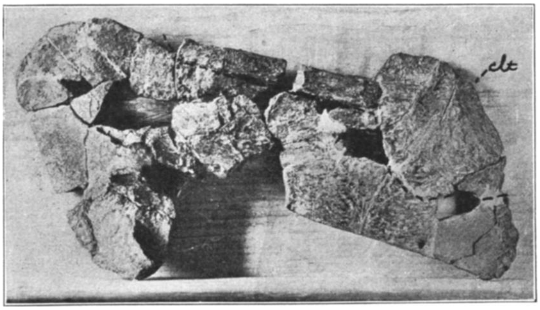


FIG. 2.—Scapula, epicoracoid, and epiclavicle of *Eryops latus*, showing the complete cleithrum. *clt.* Left side.

In *Eryops* the antero-internal edge of the bone is thickened and shows the previous attachment of a thick plate of cartilage. This mark of cartilaginous attachment extends around the anterior end of the bone from the anterior end of the face for the humerus to about the end of the anterior fourth of the upper edge, where it terminates in a small but decided angle at the point where the clavicle touched the scapula. Both the cartilaginous edge and the angulation seem to be diagnostic characters of importance, for in the reptiles they are absent. The coracoid of the Pelycosaurs has a sharp beak-like process and the anterior edge is free from cartilage. The edge of the epicoracoid is thin and the cartilage was either absent or small. In the Pelycosaurs the coracoid is always distinctly separated from the scapula by suture, and is apt to be a separate fragment in the specimen. In *Eryops*, the cotylus for the humerus is deeper and the anterior and posterior edges are raised so that the cavity is almost a semicircle; in the reptiles the cavity is shallower and more widely open. The articular face of the cotylus differs in the two. In *Eryops* it is about equal in width at the two ends, but is abruptly wider a little anterior to the middle point; in the reptiles the two ends are the wider and the middle portion is of equal width.

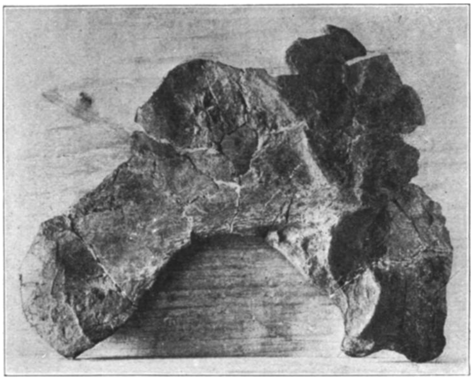


FIG. 3.—Scapula, coracoid, and epicoracoid of a diadected reptile. Right side.

A second scapula, No. 186 of the collection, differs from any heretofore seen by me in its shortness and relatively great width. As it has a free coracoid, no trace of an episcapula, and a very narrow face for cartilage on the anterior edge of the epicoracoid, it is regarded as reptilian, and its robust character shows that it belongs to some genus of the Diadectidae. It so probably belongs to a species already named that I have given it no new name here, leaving its identification to future discoveries. Fig. 3 gives the best idea of its general form. Notable, in comparison with the other scapula, is the great width of the anterior edge and the great width of the median portion, which is as wide as any part of the anterior edge. At its posterior two-thirds the bone narrows rapidly and terminates in a thin blade, which shows the marks of cartilaginous attachment on its distal and upper edges. There are two foramina in the bone in much the same position as in *Eryops*, and both open into a large pit on the inner surface of the bone. The anterior foramen opens on the outer face in a deep pit located just anterior to the prominent edge of the upper portion of the humeral cotylus, instead of somewhat farther out upon the epicoracoid, as in *Eryops*. The scapular and epicoracoidal portions meet at the suture in an angle of about 80°, as shown in the figure by the lighting of the photograph. Just distad to the cotylus in all the scapulae there is a triangular space into which opens the second of the two foramina; this portion of the bone is thickened and its edge is rounded. In *Eryops* this triangular space is marked by a deep pit and the foramen pierces the bottom of it. In the scapula under description the space is flat and the foramen enters at the apex of the triangle, which is toward the distal end of the bone. The space is marked with a V-shaped rugose line near its anterior end; no such line occurs in *Eryops*.

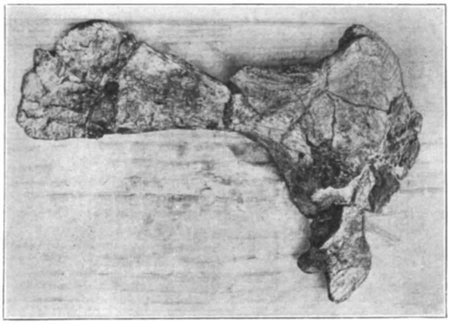


FIG. 4.—Scapula, coracoid, and epicoracoid of *Embolophorus dollovianus*. With clavicle in position. Right side.

Length of scapula No. 186	.257^{m}
Width at cotylus for humerus	.190
Width of distal end	.066

The third of the scapulae, No. 76, while distinctly amphibian, presents many reptilian characters. As shown in Fig. 4, it has a distinct cleithrum firmly attached to the distal end of the scapula, and there is no evidence of a bony coracoid; on the other hand there is no evidence of cartilaginous attachment on the coracoidal and epicoracoidal edges. The anterior foramen is located in a pit on the anterior edge of the upper extremity of the cotylus, and in this respect is much more similar to the reptiles than to the amphibians. The triangular space distad to the cotylus is filled and marked by a V-shaped rugosity, as in the Diadectid scapula.

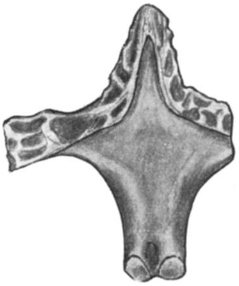


FIG. 5.—Dorsal spine of *Zatrachys crucifer*. From behind.

In *Dimetrodon* and *Embolophorus* the anterior foramen opens close to the strongly projecting upper edge of the cotylus;

there is no triangular area, and the posterior foramen opens on the summit of a ridge directly posterior to the elevated edge of the cotylus. Fig. 4 shows the scapula of the right side of *Embolophorus dollovianus*, with the almost perfect clavicle in its normal position.

At this point may be noted a peculiar relation which exists between the scapulae of the American and the African reptiles. In Clepsydropsidae there is no trace of the attachment of the clavicle to the scapulae, except in the problematical facet figured by Cope as possibly forming an articulation for the clavicle. In the Dicynodonts and the Theriodonts there is a distinct process on the scapulae for the clavicle, and this exists even in *Pareiasaurus* where the epiclavicle is still present. In *Cynognathus* this process has developed into a strong scapular spine which occupies the upper edge of the scapula nearly in the same position as is the scapular spine of the Monotremes.

Zatrachys crucifer. sp. nov.

A single neural spine, No. 171 of the Chicago collection, indicates a new form which I have referred to a new species of the genus *Zatrachys* Cope. As shown in Fig. 5, the spine has a cruciform shape with a sharp upper portion and short lateral processes. The posterior zygapophyses are preserved and are relatively small. The upper faces of the lateral processes and the apex of the spine are pitted by a deeply marked rugosity so that the whole upper surface of the spine is excavated by deep pits of a size and depth seen before only in the larger amphibians, *Eryops*, and *Cricotus*. The lower surfaces of the later processes and the sides of the base of the spine are smooth. The anterior and posterior edges of the apex are free from the deep pits and are marked by a narrow space of striations showing that the spine was overlapped by the edges of some other element; it is evident from the shape of the spine that this could not have been the edges of the adjacent spine, but must have been an extra element intercalated between the spines, probably one of the dermal ossifications such as occur along the spine of *Pareiasaurus*. The nearest approach to this condition is found in the rugose expanded apices of *Zatrachys apicalis* Cope, and so I have referred this specimen to that genus until further information may be obtained. Fig. 5. The fragment is $.054^{m}$ in height and $.058^{m}$ across the lateral processes.

DIADECTIDAE.

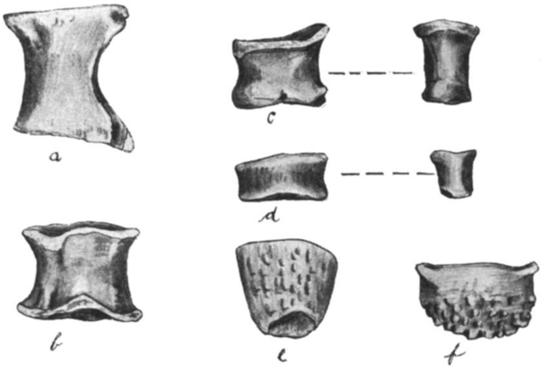
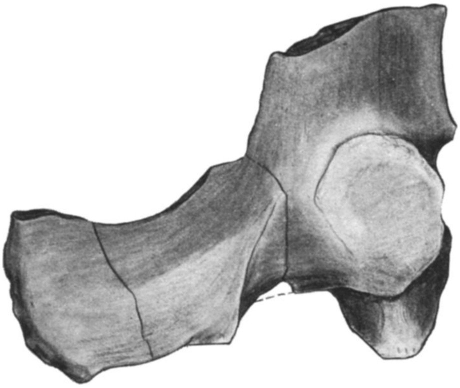


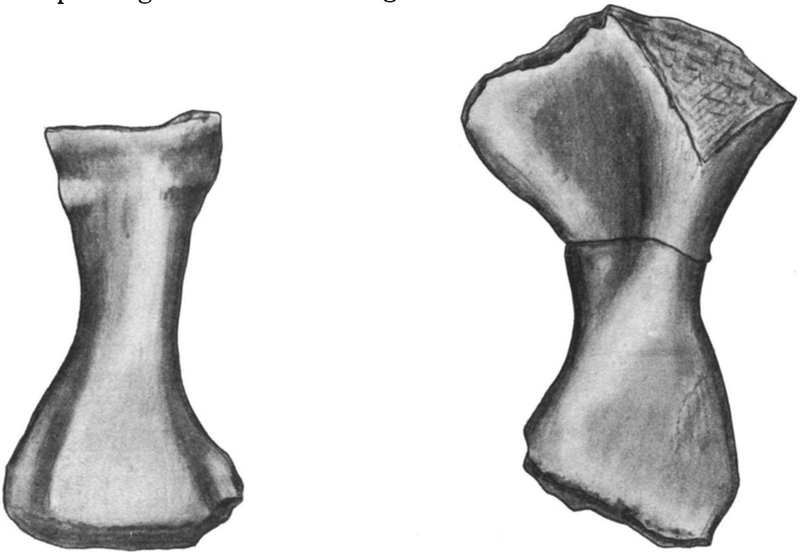
FIG. 6.—Foot bones of a diadected reptile; *a* and *b* metacarpals (?); *c*, *d*, *e*, phalanges found united; *f*, another terminal phalange.

The family Diadectidae is known so far from the skull, teeth, vertebrae, pelvis, clavicle, and interclavicle; to this we may add the scapulae, if the specimen described above belongs, as assumed, to this family. The separation of genera and species has been done almost entirely upon the characters of the teeth and skull, so that it has been impossible to determine accurately the position of isolated bones. A specimen in the Chicago collection (No. 62) makes it possible to add a description of the caudal vertebrae, some of the bones of the limb and foot, and especially the presence of an unsuspected structure, *i. e.*, dermal plates overlying the ribs and corresponding to them in number. This last structure is shown in two separate fragments; the largest shows five ribs in place and the plates covering them. It is impossible to say which side the fragment is from. The ribs are quite stout and show a large medullary cavity. The plates are large and thin. Their edges are broken away so that their size cannot be determined. The plates lie one over the other like shingles. The plate at one end has the end broken and turned down. Near this is a separate fragment which may be either a portion broken off from the edge of the plate or a distinct marginal plate. The approximate width of each of the plates is $.033^{m}$ and the length of the fragment is about $.160^{m}$.

The limb bones consist of the lower end of a humerus, two bones of the fore limb and a fragment of the carpus (?) with the distal end of a bone of the forearm (?) attached. Besides these there are several phalanges, some in connected series. The phalanges and metacarpals (?) are remarkably short and strong and the terminal phalange was covered with a very stout claw bearing out the suggestion made by Cope that the animals were fossorial in habit. Unfortunately there are not more than three phalanges united in any one fragment, and there are six terminal phalanges altogether, so that it is impossible to state the exact number of phalanges in the digits, but it is probable that the usual reptilian formula was present. The phalanges are shown in Fig. 6.



FIGS. 7.—Lower end of humerus of a diadected reptile. Left side.



FIGS. 8 and 9.—Limb bones of same specimen as Figs. 6 and 7.

The bones of the limb are stout and short. The humerus is very imperfect, only the lower portion being preserved, but it indicates a very stout bone, and the lower end is strikingly similar to that of *Eryops;* the head for the radius is very large and is located almost entirely on the anterior side of the bone ; just posterior to it is a strong descending process that reaches below the lower end of the bone. Fig. 7. There is a distinct ectepicondylar process on the outer side of the bone. There is no entepicondylar foramen visible, but the bone is broken below where this should appear. The two other limb bones are shown in Figs. 8 and 9.

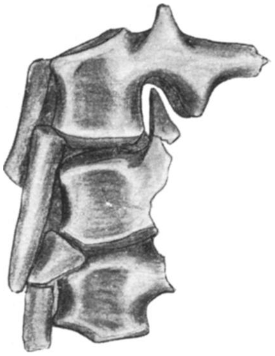


FIG. 10.—Caudal vertebræ from same specimen as that shown in Figs. 6–9.

The caudal vertebræ differ markedly from the typical dorsals. The centra are as high as long and the neural spine is as high as the length of the centrum. The centrum is not broader than long and is deeply amphicœlous. There are well-developed anterior and posterior zygapophyses, but no trace of zygosphene or zygantrum. The lower side of the vertebræ is marked by the exceptionally strong and elongated chevron bones ; they are attached between two adjacent vertebræ, and there is a strong face on the lower edge of the posterior surface of the preceding vertebra for the attachment of the head of the chevron. The caudals with chevrons are shown in Fig. 10.

MEASUREMENTS.

Length of the longest limb bone	.106$^{\mathrm{m}}$
Width of the complete end	.065
Length of the shortest limb bone	.087
Width of its widest end	.047
Width of its shortest end	.036
Length of three caudals	.061
Height of the first from the base of centrum to top of spine	.044
Horizontal diameter of centrum of first	.012
Vertical diameter of centrum of first	.019
Length of a complete chevron	.031

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